



FORECASTING SPACE WEATHER IN CANADA

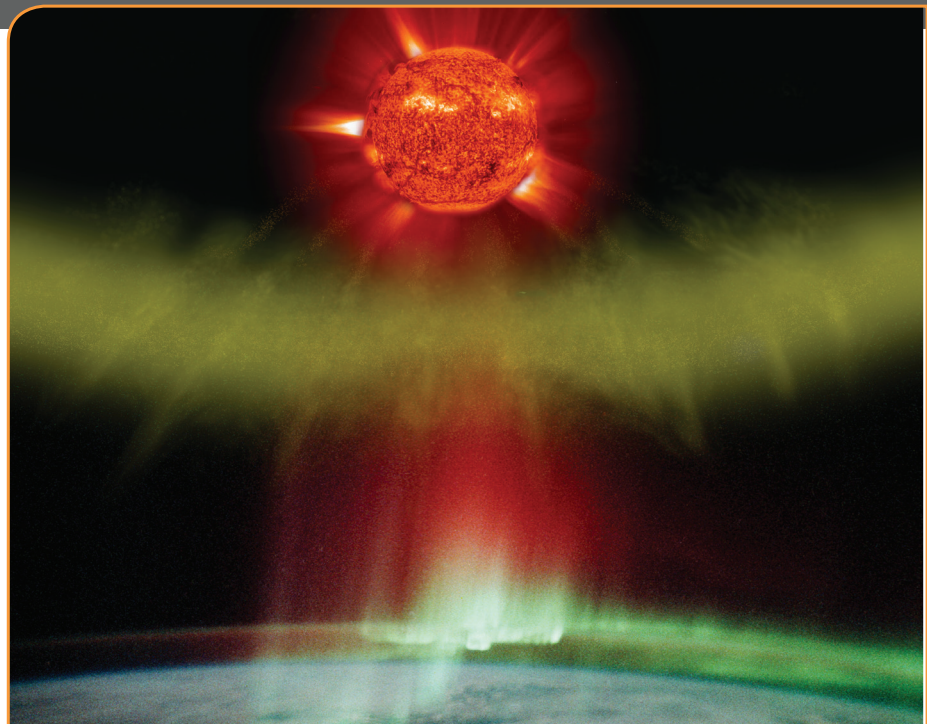
Space weather refers to the conditions and processes occurring in space which have the potential to affect the near Earth environment. Space weather processes can include changes in the interplanetary magnetic field, coronal mass ejections from the Sun, and disturbances in Earth's magnetic field. The effects of space weather can range from damage to satellites to disruption of power grids on Earth.

Space weather forecasts provide crucial information for anyone who might be impacted by space weather: airline pilots, astronauts, power utility engineers, mineral exploration geophysicists, and even tourists hoping to catch a glimpse of the northern lights.

Why is space weather forecasting important?

Space weather causes disturbances of the magnetic field that shields the Earth from charged particles emitted by the Sun. An effect of these disturbances can be the colorful northern lights or aurora borealis — a common result of geomagnetic storms which occurs when energized particles from the Sun interact with the Earth's upper atmosphere.

Composite image showing the impacts of aurora on Earth courtesy of SOHO, ESA and NASA.



Geomagnetic laboratory in Ottawa.



Technician performs maintenance on a magnetic observatory at St. John's, Newfoundland.



Calibrations are routinely carried out on the magnetic data from across the network.



Space weather can also have significant impacts on the technological infrastructure we've come to rely on, including:

- Interference with radio-wave signals (navigation systems and radio communications)
- Electric power grid disturbances
- Pipeline corrosion
- Satellite operational problems
- Radiation hazard for astronauts and pilots flying at high altitudes

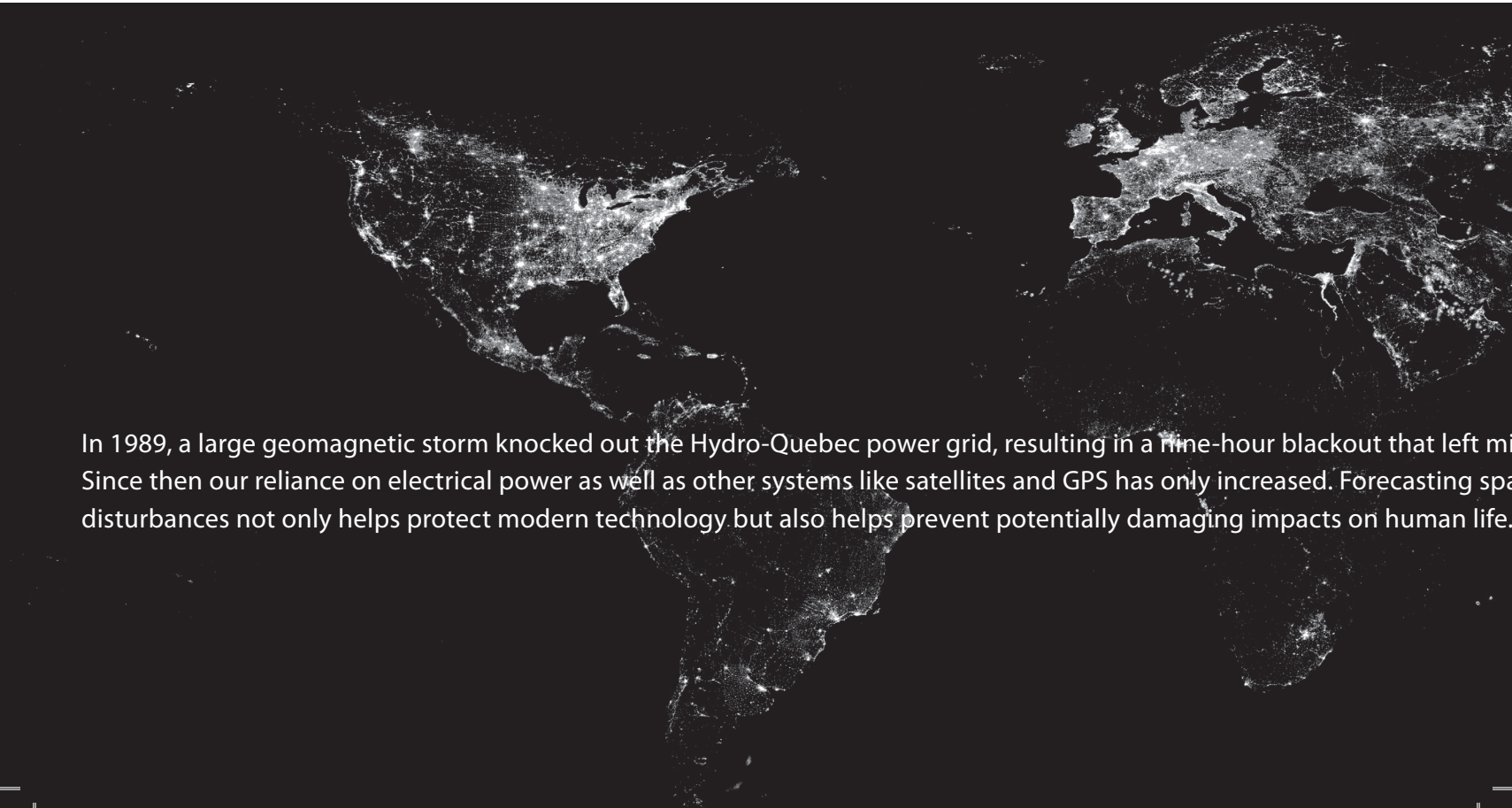
Space weather forecasting in Canada

The Geomagnetic Laboratory of Natural Resources Canada (NRCan) is the Government of Canada's headquarters for the Geomagnetic Monitoring Service and the Canadian Space Weather Forecast Centre.

The Canadian Space Weather Forecast Centre monitors, analyzes, and forecasts space weather and dispatches warnings and alerts across Canada. This includes tracking solar disturbances from the Sun to the Earth and monitoring the Earth's magnetic field on the ground using a network of magnetometers distributed throughout Canada. The centre also contributes to the International Space Environment Service by providing geomagnetic data and space weather forecasts.

How is the forecast created?

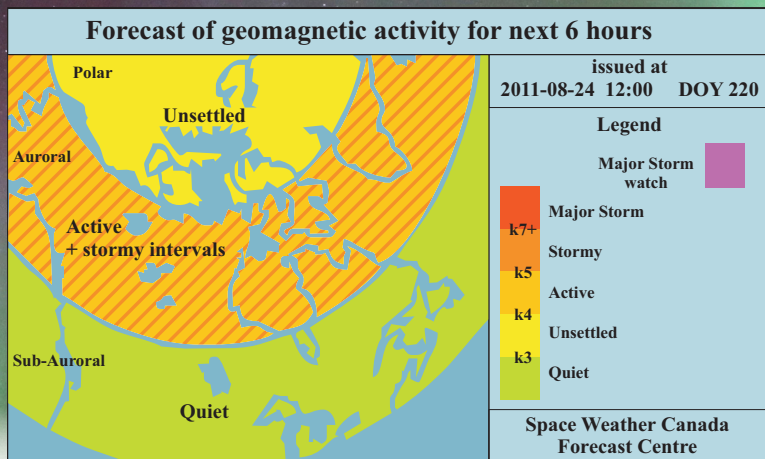
Geomagnetic activity is forecast using NRCan's network of magnetometers and data from instruments that monitor the Sun. The Advanced Composition Explorer and Solar and Heliospheric Observatory Satellites (funded and operated by the U.S. National Aeronautics and Space Administration and



In 1989, a large geomagnetic storm knocked out the Hydro-Quebec power grid, resulting in a nine-hour blackout that left millions of people without power. Since then our reliance on electrical power as well as other systems like satellites and GPS has only increased. Forecasting space weather disturbances not only helps protect modern technology but also helps prevent potentially damaging impacts on human life.

t on the
network.

Forecast of geomagnetic activity in the three zones across Canada
with the auroral zone experiencing the most activity.



AuroraMAX images of the northern lights above Yellowknife provided courtesy of AuroraMAX. (Canadian Space Agency, Astronomy North, University of Calgary, City of Yellowknife)

es,
European Space Agency), located 1.5 million kilometres above the Earth, are good examples of instruments for solar monitoring. Magnetometers and charged particle detectors are used to give advanced notice of potentially harmful space weather periods. Scientists look at patterns and clues in the data collected to produce a forecast.

What does the forecast look like?

Forecasts are provided for three zones in Canada (polar, auroral, and sub-auroral). For each zone, the forecast has five classifications, as shown in the legend above.

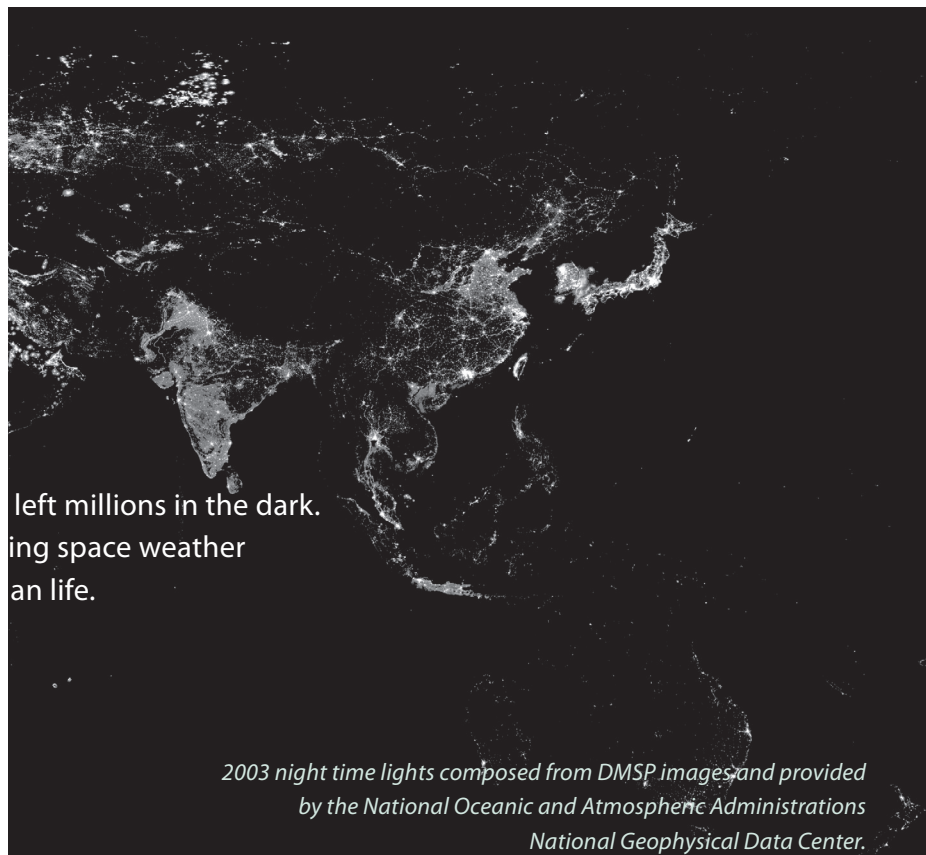
In general, the auroral region is the most active zone. During stormy or major storm periods, technological systems are at the greatest risk of damage.

Where do I get the forecast?

Up-to-date descriptions and forecasts of space weather are available online at spaceweather.gc.ca. In the event of a power outage, the forecast can also be heard by phone (613-992-1299).

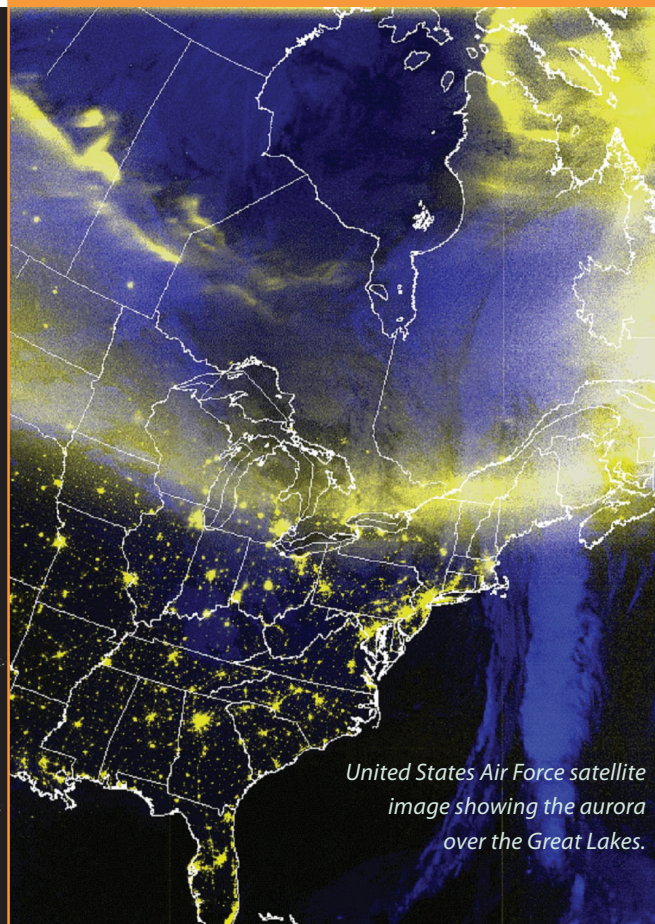
Forecasts are updated every fifteen minutes and are based on a combination of near real-time measurements from ground-based observatories and satellites. Major Storm Watches are posted on the website and issued directly to members of Canadian industry.

Did you know? Scientists predict more severe space weather in 2012 and 2013 due to a rise in solar activity in the Sun's eleven-year cycle.



left millions in the dark.
ing space weather
an life.

2003 night time lights composed from DMSP images and provided by the National Oceanic and Atmospheric Administrations National Geophysical Data Center.



United States Air Force satellite image showing the aurora over the Great Lakes.

Preventing damage from space weather

Scientists in the Canadian Space Weather Forecast Centre both monitor and research space weather and its impacts on a variety of technologies. Their goal is to reduce the risk of interruptions to the safe operation of critical infrastructure, such as power grids, pipelines, satellites, communication, and navigation. In collaboration with other government departments, universities, and industrial partners, NRCan researchers have provided many important contributions to reduce the vulnerability of critical technology to space weather hazards. These include modeling and monitoring geomagnetic effects on power systems and pipelines. NRCan researchers continue to investigate new and emerging topics to improve space weather forecasts.



*Above: Canadian Space Weather Forecast Centre.
Right: Measuring current in a buried pipeline.*

You may also want to read
“Space Weather” and “Space Weather
— Effects on Technology”.

Government of Canada work on space weather and geomagnetic storms is undertaken by Natural Resources Canada, Earth Sciences Sector. For more information, please visit the NRCan Space Weather Canada website: spaceweather.gc.ca.

Canadian Space Weather
Forecast Centre
2617 Anderson Road,
Ottawa, ON K1A 0E7
Tel: 613-837-4241